SECTION 20 70 23

ELECTRONIC CIRCUITS, WIRES, AND CABLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Optical transmission cable

B. Telephone cables

C. Video cable

D. Category 5 cables

1.02 RELATED SECTIONS

A. Interface and coordinate the work of this Section with Section 20 70 26 - Common Materials and Methods for Electrical Systems, Section 20 50 13 - Raceways for Facility Services, Section 26 05 24 - Low and Medium Voltage Wires and Cables, and Section 20 70 13 - Common Materials and Methods for Electronic Services.

1.03 MEASUREMENT AND PAYMENT

A. General: Electronic circuits, wires, and cables, as specified herein, will not be measured separately for payment but will be paid for as part of the Contract lump-sum price for the related item of work in the Bid Schedule of the Bid Form.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials

B. California Code of Regulations (CCR):

1. CCR Title 24, Part 3, California Electrical Code

C. Electronics Industries Association (EIA):

1. EIA 359-A Standard Colors for Color Identification and Coding

2. EIA TIA-455-A Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

3. EIA TIA-455-3 FOTP-3 Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components

4. EIA TIA-455-13 FOTP-13 Visual and Mechanical Inspection of Fibers, Cables, Connectors and/or Other Fiber Optic Devices

5. EIA TIA-455-25 FOTP-25 Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies

6. EIA TIA-455-30 FOTP-30 Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity

7. EIA TIA-455-41 FOTP-41 Compressive Loading Resistance of Fiber Optic Cables

8. EIA TIA-455-47 FOTP-47 Output Far Field Radiation Pattern Measurement

9. EIA TIA-455-51 FOTP-51 Pulse Distortion Measurement of Multimode Glass Optical Fiber Information Transmission Capacity

10. EIA TIA-455-59 FOTP-59 Measurement of Fiber Point Defects Using an OTDR

11. EIA TIA-455-61 FOTP-61 Measurement of Fiber or Cable Attenuation Using an OTDR

12. EIA 455-88 FOTP-88 Fiber Optic Cable Bend Test

13. EIA 455-91 FOTP-91 Fiber Optic Cable Twist-Bend Test

14. EIA 455-104 FOTP-104 Fiber Optic Cable Cyclic Flexing Test

15. EIA 455-171 FOTP-171 Attenuation by Substitution Measurement - for Short-Length Multimode Graded-Index and Single-Mode Optical Fiber Cable Assemblies

16. EIA TIA-4720000-A Generic Specification for Fiber Optic Cable

17. EIA 492 AAAA Detail Specification for 62.5-μm Core Diameter/125-μm Cladding Diameter Class 1a Multimode, Graded Index Optical Waveguide Fibers

18. EIA TIA-598-A Optical Fiber Cable Color Coding

19. EIA TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

D. Insulated Cable Engineers Association, Inc. (ICEA):

1. ICEA S-84-608 Telecommunications Cable Filled, Polyolefin Insulated, Copper Conductor Technical Requirements

E. Institute of Electrical and Electronics Engineers (IEEE):

1. IEEE 383 Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

F. National Electrical Manufacturers Association (NEMA):

1. NEMA WC7 Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

G. National Fire Protection Association (NFPA):

1. NFPA 258 Standard Research Test Method for Determining Smoke Generation of Solid Materials

H. Rural Electrification Administration (REA):

1. REA PE-210 Crystalline Propylene-Ethylene Copolymer Raw Material

2. REA 345-67 Filled Telephone Cables

I. Underwriters Laboratories Inc. (UL):

1. UL 1581 Electrical Wires, Cables, and Flexible Cords

2. UL 1666 Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

1.05 SUBMITTALS

A. General: Refer to Section 01 33 00 - Submittal Procedures, and Section 01 33 23 - Shop Drawings, Product Data, and Samples, for submittal requirements and procedures.

B. Submittal Requirements: Before installation of wires and cables, submit the following applicable information for each type and size of wire and cable.

1. Manufacturer of wire and cable, and certificate of compliance;
2. Number and size of strands composing each conductor;
3. Conductor insulation composition type in accordance with California Electrical Code and thickness in mils;
4. Average overall diameter of finished wire and cable;
5. Minimum insulation resistance in megohms per 1000 feet at 30 degrees C ambient;
6. Jacket composition and thickness in mils;
7. Total number of conductors per cable;
8. Shield material (if any) and thickness;
9. Conductor resistance and reactance in ohms per 1000 feet at 25 degrees C ambient; and
10. Conductor ampacity at 30 degrees C ambient for 600 V wire and cable, 20 degrees C ambient earth temperature, 100 percent load factor and conductor temperature of 90 degrees C for wire and cable rated 2 kV to 5 kV.

C. Fiber optic Cable Samples: For fiber optic cables, a 100-foot sample of each optical cable type, single mode and multimode, of the respective sizes indicated, shall be submitted together with full technical specifications for each cable design and construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide markings on wire and cable in accordance with applicable NEMA and California Electrical Code requirements. Each item shall be labeled with UL listing approval.

B. Ship each unit securely wrapped, packaged, and labeled for safe handling in shipment and to avoid damage.

C. Store wire and cable in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 OPTICAL TRANSMISSION CABLE

A. Fiber optic cables shall be manufactured in accordance with EIA TIA-455-13, EIA TIA-455-25, EIA TIA-455-41, EIA TIA-455-47, EIA TIA-455-59, EIA TIA-455-61, EIA 455-88, EIA 455-91, EIA 455-104, and EIA 455-171. Fiber optic cable assemblies, including jacketing and fibers shall be certified by the manufacturer to have a minimum life of 30 years.

B. Cable Type: Provide optical cable of the types indicated herein.

1. Cable Characteristics:

a. Count of optical fibers in each cable run, including fibers reserved for future use and for spares, shall be as indicated.

b. Fibers shall be either single-mode loose tube lightpack or multi-mode, as indicated, tight buffered or other versatile cable design that will provide the required performance for the harsh environments of the BART network.

c. Physical makeup of single mode and multimode fiber cables shall include composite protective coating on each fiber, rod fillers if required, color-coded components, a synthetic yarn-strength members, a reinforced inner jacket, an intermediate metallic wrap, and an insulating and protective extruded outer jacket.

d. Outside diameter of outer jacket shall be one inch, maximum.

e. Each shipping length of cable shall be permanently identified by printing on the outer surface of the jacket, at intervals of five feet or less. Information shall include count of fibers, fiber type and size, cumulative footage markers, manufacturer's designation, plant name (if applicable), and manufacturer's name.

2. Optical Fiber Characteristics for Single-Mode Trunks:

a. Type: single-mode

b. Operating wavelength: 1310/1550 nm

c. Attenuation at 1310 nm: 0.4 dB/km, maximum
Attenuation at 1550 nm: 0.3 dB/km, maximum

d. Maximum dispersion slope: 0.095 ps/(nm2□km) over the wavelength range of 1285 nm to 1570 nm

e. Cut-off wavelength: 1260 nm +/- 70 nm

f. Fiber mode diameter: 9.5 μm +/- 1.0 μm

g. Fiber outer diameter: 125 μm +/- 3.0 μm

h. Each tube and fiber shall be color-coded to provide unique and permanently visible identification, in accordance with EIA 359-A.

3. Optical Fiber Characteristics for Multimode Paths:

a. Type: graded index multimode

b. Operating Wavelength and Bandwidth: 160 MHz·km at 850 nm and 500 MHz·km at 1300 nm.

c. Attenuation at 850 nm: 3.75 dB/km, maximum
Attenuation at 1300 nm: 1.00 dB/km, maximum

d. Core diameter: 62.5 μm +/- 3.0 μm

e. Cladding diameter: 125.0 μm +/- 2.0 μm

f. Each tube and buffered fiber shall be color-coded to provide unique and permanently visible identification, per EIA 359-A.

4. Optical Performance: The attenuation shall be measured in accordance with EIA TIA-455-61. The bandwidth shall be measured in accordance with EIA TIA-455-30 or EIA TIA-455-51.

5. Loose Tube Cable Characteristics:

a. Central strength member shall be a glass-fiber-reinforced dielectric material;

b. Loose tubes shall be made of a tough abrasion-resistant material, to provide mechanical and environmental protection for the optical fibers;

c. Water-blocking compound shall be provided within the tubes;

d. If fillers are required, they shall be made of a low-smoke, low-halogen polyolefin compound, containing less than 0.5 percent halogen by weight;

e. Inner jacket shall be made of a low-smoke, low-halogen, cross-linked polyolefin, containing less than 0.5 percent halogens by weight.

6. Tight Buffered Cable Characteristics:

a. Fibers to be tight buffered to 900 μm diameter, using a tough elastomeric buffer material.

b. Buffered fibers to be stranded together with dielectric strength members.

c. Inner cable jacket to be pressure-extruded onto cabled fibers and strength members in the core assembly. This jacket material shall be of zero-halogen flame-retardant composition.

7. Outer Jacket Assembly for Both Loose Tube and Tight Buffer Cables:

a. Jacket material shall be a flame-retardant, low-smoke, low-halogen insulating compound that is ultraviolet (UV) resistant. For tight-buffered cables, the outer jacket shall be extruded over the shield/armor in a tight-fitting assembly.

b. A 0.006-inch thick (minimum) corrugated electrolytic chrome coated steel tape, plastic coated on both sides, shall be tightly wrapped, around the inner jacket.

c. A ripcord (or two ripcords) of compatible material shall be built into the cable assembly, to facilitate removal of the wrap and jackets during installation.

8. Overall Physical Characteristics of Cable:

a. Cable design to conform with EIA TIA-4720000-A, and EIA TIA-455-A, including Addenda 455 (1-190), unless indicated otherwise.

b. Pulling Load (installation): 600 lb, minimum

c. Operating Load: 112 lb, minimum

d. Resistance to Crush: 700 lb/in for 60 seconds

e. The minimum bending radius shall be 20 times the outside diameter of the cable.

9. Environmental Characteristics:

a. Completed fiber optic cable of either type shall comply with the flame-retardant requirements of IEEE 383.

b. Cable jacket material (inner and outer jackets) shall have specific optical densities of less than 200 in the non-flaming mode and 75 in the flaming mode, when tested per ASTM E662.

c. Cable jacket material (inner and outer jackets) shall have a halogen content of less

than 0.5 percent by weight.

d. Completed cable, of either type, shall have a toxicity index of less than 5.0 in accordance with EIA TIA-455-3.

10. Identification:

a. Color Coding: The individual fibers shall be color coded for identification in accordance with EIA TIA-598-A. The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered on the unit jacket for identification. The number shall be repeated at regular intervals.

b. Jacket Printing: The outer jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every 2 feet (e.g. "COMPANY - 01/97 -62.5/125 MICRON - Type OFNR - (UL) 00001 FEET"). The print color shall be black. The printing shall be permanent and legible for the life of the cable.

2.02 TELEPHONE CABLES

A. Conductors: Conductors shall be solid soft or annealed bare copper in accordance with REA 345-67 and ICEA S-84-608. In factory joints, the ends of the conductor shall be butted and shall be free of lumps and sharp projections. The tensile strength of a conductor containing a factory joint shall be not less than 85 percent of the tensile strength of an adjacent section of the solid conductor of equal length that has no joint.

B. Insulation: Each conductor shall be insulated with a colored, solid, insulating grade propylene/ethylene copolymer meeting the requirements of REA PE-210, Appendix A. The insulation shall be colored to identify the tip and ring conductor of each pair, and each pair in the completed cable. The insulation shall meet the following requirements:

1. Tensile strength, psi, minimum: 3,000

2. Elongation, percent, minimum: 300

C. Core Assembly and Unit Binders: In cables having 50 pairs or more, the pairs shall be arranged in groups of 25 pairs. Each group shall be bound with a moisture-resistant string or color-coded tape. Groups may be divided into sub-groups, each of which shall be bound with the binder color assigned to the group. Tapes used as binders shall be non-hygroscopic, non-wicking, and shall be colored. Binders shall be applied with a layer of not more than four inches.

D. Filling Compound: The filling compound shall be a homogeneous, non-hydroscopic, semi-solid compound formulated to maintain its protective properties throughout normal operating temperatures and over long term aging. The compound shall be uniformly mixed and shall be as colorless as possible for ease of pair identification. The compound shall be free from dirt, metallic particles, and other foreign matter. The compound shall be non-toxic and present no dermal hazards. The compound shall be compatible with all cable components. Fillers shall be gel-filled PE-39 conforming to REA 345-67.

E. Shield: A minimum of 5 mil copper tape that complies with ICEA S-84-608, including a tinned copper drain wire conforming to PE-39, REA 345-67.

F. Jacket: Cable jacket material shall not be restricted to the materials specified in PE-39, REA 345-67, but shall be selected along with internal components of the cable assembly.

G. The completed cable shall comply with the following additional requirements:

1. Low smoke qualification: ASTM E662

2. Low toxicity qualification: NES 713

3. Flame retardant qualification: IEEE 383

4. Halogen content: 0.5 percent by weight, maximum

5. Thickness of jacket: ICEA S-84-608, Paragraph 7.2.2.

H. Color Coding of Conductors: Conductor color-coding shall be in accordance with Section 26 05 24 - Low and Medium Voltage Wires and Cables. Telephone cables shall be color-coded to identify the tip and ring conductors of each pair and to identify each pair in the completed cable.

2.03 VIDEO CABLES

A. Provide coaxial cables for video signal transmission; 75 Ω characteristic impedance; double braided copper shield and an AWG No. 20 solid copper center conductor.

2.04 CATEGORY 5 CABLES

A. Category 5 cables shall be manufactured in accordance EIA/TIA 568.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate installation of communication circuit wires and cables with the requirements of Section 20 70 26 - Common Materials and Methods for Electrical Systems, Section 20 50 13 - Raceways for Facility Services, Section 26 05 24 - Low and Medium Voltage Wires and Cables, and Section 20 70 13 - Common Materials and Methods for Electronic Services.

B. Fiber optic cables for Train Control and Communication Systems shall be installed as follows:

1. Communication cables between Stations shall be installed in one of the five innerducts in the Communications section of the system wide raceway.

2. Train control cables between Train Control Rooms or Houses shall be installed in innerducts in the Train Control section of the systemwide raceway.

3. Lateral cables to Train Control Rooms or Houses shall be installed in separate innerducts.

4. Communication cables between BART facilities and train control cables from Train Control Rooms or Houses to wayside devices may be without innerducts in the systemwide raceway.

3.02 IDENTIFICATION

A. Identification of wires and cables shall be in accordance with Section 26 05 24 - Low and Medium Voltage Wires and Cables.

B. Labeling: Identification tags or labels shall be provided for each cable. Markers, tags and labels shall use indelible ink or etching which will not fade in sunlight or in duct applications. Markers, tags, and labels shall not become brittle or deteriorate for 30 years. Label all termination panels with cable number or pair identifier for cables in accordance with EIA TIA-606 and as specified. The labeling format shall be identified, and a complete record shall be provided to the District with the final documentation. Each cable shall be identified with type of signal being carried and termination points.

3.03 TESTING

A. General: Testing shall be in accordance with Section 01 45 24 - Testing Program Requirements.

B. Fiber Optic Cable Tests: Manufacturer's test results and certifications for specified tests shall be submitted. Fiber optic cables shall be tested for end-to-end continuity, power level, and loss evaluations. In addition, the following tests shall be performed:

1. Verification that factory packaging is undamaged and intact.

2. Verification of continuity, attenuation, and absence of anomaly for each reel.

3. Inspection of the appearances of each end of each installed unspliced cable run.

4. Optical time-domain reflectometer (OTDR) tests of each splice.

5. Continuity and attenuation for each fiber in each terminal-to-terminal link, tested in both directions.

END OF SECTION 20 70 23